U.S. Department of Transportation
Urban Mass Transportation Administration

Bill Handling Problems in Bus Fare Collection

Office of Technical Assistance
Office of Bus and Paratransit Systems

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TECHNOLOGY SHARING A PROGRAM OF THE UNITED STATES DEPARTMENT OF TRANSPORTATION

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of Transportation
**Urban Mass
Transportation
Administration**

Bill Handling Problems in Bus Fare Collection

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Office of Technical Assistance
Office of Bus and Paratransit Systems
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This report is submitted in fulfillment of Subcontract No. D-00421-S with Dynatrend, Inc., for their Contract No. TRS-57-80-C-00081 with the U. S. Department of Transportation's Transportation System Center in Cambridge, Massachusetts. This research was accomplished under the direction of Mr. Joseph Koziol of TSC.

The transit agency data contained in this report was collected between January and March, 1982.

EXECUTIVE SUMMARY

Custom Engineering, Inc. conducted a research program under the auspices of the DOT Transportation System Center. The purpose was to identify, define and recommend potential solutions to the problems confronted by bus properties in handling dollar bills in their fare collection systems. Conducted through the mechanism of interviews with eight properties, each was selected on the basis of system size and/or a unique approach to the bill handling problem. A series of questions was developed for the interviews, two of which were conducted on-site and six via phone calls. Further, in order to illustrate the operational problems and focus the findings, one fare collection system was examined in detail. Convenience, cost and willingness of the property led to the Regional Transportation System, Denver, Colorado, being selected for this purpose.

Bill handling problems enumerated by the properties fall into three general categories:

- Equipment Reliability and Maintenance
- Bill Handling Costs
- Lost Revenue

Without exception, properties we interviewed using electronically registering fareboxes experienced difficulties with them when they were first introduced. The problems centered largely around the reliability of the electronics and electrical connectors in the bus operating environment, and jamming of rotating farebox vaults when bills and coins are mixed in the same vault. The properties solutions to the electronics reliability varied from disconnecting them at the Denver RTD, to hiring an electronic engineer to maintain the boxes in Pueblo, Colorado. One of the findings of this study is that the costs of keeping the electronically registering fareboxes operating is still relatively high. This is shown in the Table below:

TYPE OF FAREBOX	NO. OF PROPERTIES	FAREBOXES MAINTAINED PER MAINTENANCE PERSON
Non-Registering	2	170-175
Registering	3	60-75

The 250-300 percent increase in maintenance staff required for the electronic registering farebox is very high. The benefits provided by the registration must be correspondingly high for it to be warranted. A more appropriate solution would seem to be to substantively reduce the high maintenance costs. This could be accomplished, for example, by modifying the design to achieve a higher reliability in the bus operating environment.

In this regard strong consideration should be given to developing a bus Operating Environment Specification that fareboxes would have to pass before being purchased. If it were a joint effort between the suppliers, the industry (user), and UMTA (financier), it could be accomplished to the advantage of all parties. Such an approval is not without precedent; it is analogous to Underwriters Laboratory (UL) approval for consumer electrical appliances.

The costs experienced by the properties in sorting, stacking and counting bills is also high, as shown below:

BILLS HANDLED DAILY	BILLS/PERSON/HOUR AVERAGE
Up to 1,000	80-150
3,000 to 11,000	220-460

The two-to-one variation in each category is indicative of the data preciseness, and performance variations. The difference in performance levels for the two categories is attributed to amortization of supervision for the process. Using average labor rates for the industry, the cost of sorting, stacking and counting dollar bills is at least between 2¢ and 10¢ per bill, with the present technology. There are other costs not accounted for in this range. The solution to these high costs is to eliminate the great amount of labor involved in handling bills. Fareboxes designed to handle dollar bills should also stack them in a separate vault rather than mix them with the coins, resulting in two benefits. If the separate vault was designed to interface with existing bill counters the bill handling costs would be greatly reduced. Secondly, vault jams, torn bills and loose bills (Figure 8B) would all be reduced. Further, as many vault jams are cleared by using crow bars, vault repair costs should also be reduced.

In short, much can be done to reduce the costs of handling dollar bills if a systems approach, rather than an individual piece of hardware approach, is used in addressing the problems.

A further cost of handling dollar bills surfaced during this research--the rather high level of lost revenue the properties believe they are experiencing. Pilferage has long been suspected in bus operations but the level estimated has not been very high. However, the increased use of the dollar bill makes the fare collection system susceptible to much larger scale losses. The properties believe they are experiencing these losses, as shown in the Table below:

LOST REVENUE / DEPOSITED REVENUE (PERCENT)	NO. OF PROPERTIES
Minimal	2
10-15	1
15-20	3
As High as 25	2

If these estimated losses are anywhere near correct, eliminating or substantially reducing them offers the potential for enormous revenue increases. To illustrate the potential, using the 15-20 percent loss as a percentage of 1980 trolley coach and motor bus revenue from APTA's Fact Book, between 25 and 33 percent of the 1980 Federal Operating Assistance to the properties was lost to theft. If true, a "closed loop" fare collection system that removes the money from the vehicle altogether offers a potential avenue to solving the problem.

INTRODUCTION

The Transportation Systems Center of the Department of Transportation has undertaken a project under sponsorship of the Urban Mass Transportation Administration, and in cooperation with the American Public Transit Association, to improve the effectiveness of bus fare collection systems to satisfy the needs of the various transit agencies. The purpose of the research reported herein is to support TSC's project of providing the technical information and analysis needed to understand and define more clearly the specific issues and problem areas faced by properties in their daily operations. The focus of the effort was the growing problem within the industry of handling dollar bills in the fare collection system. The intent of this project is to provide a preliminary evaluation of a typical fare collection system, including the problems of handling dollar bills.

Historically, bus transit fares have been collected predominantly on board the vehicle. Current bus transit fare collection procedures rely primarily on exact cash fare payment into secure fareboxes. As large numbers of fareboxes currently in use were designed to handle coins and/or tokens, they do not readily accept dollar bills. Hence, a great deal of manual effort is added to the fare handling task at a significant increase in cost to the property. The purpose of the project is to concentrate on the existing technical problems of bus transit operators and is directed at increasing fare revenue return, reducing operating costs and improving passenger services.

The research was organized in a series of sequential phases. Each is discussed in a separate section of this report.

It should be noted that many people at a number of properties contributed to this effort. Each is acknowledged in the appropriate section.

APPROACH

In order to determine the scope of the problem of handling dollar bills from the small sampling of properties that could be contacted within the resources allocated to this study, a series of parameters were developed that would permit assessing the extent of the problem by property size, fare structure and fare collection methods. A set of questions was developed to be used in telephone interviews with various-sized properties. These questions were subsequently modified as a result of our discussions with the properties. The intent of the questions was to be able to categorize the problems caused by paper bills, both by type and severity, in order to prioritize further actions. Severity was judged on the basis of cost and impact on operations. Because precise cost data gathering was outside of the scope of the present research, only approximate metrics were developed. Examples of these are the number of fareboxes a full-time employee can maintain, and the number of bills a person can sort and count in a day, rather than a dollar value of costs. In this approach, individual property salary structures are not an issue.

It was postulated that the scope of the problems and the solutions being used were a function of property size. Hence, four size categories were developed and properties to be interviewed were identified in each category. These are shown below:

VERY LARGE SYSTEMS (More than 1000 Buses)

Massachusetts Bay Transit Authority, Boston, Massachusetts
Southeastern Pennsylvania Transit Authority, Philadelphia, Pennsylvania

LARGE SYSTEMS (500-1000 Buses)

Regional Transportation District, Denver, Colorado

SMALL SYSTEMS (200-500 Buses)

Central Ohio Transit Authority, Columbus, Ohio
Metropolitan Suburban Bus Authority, East Meadow, New York

VERY SMALL SYSTEMS (Less than 200 Buses)

City Transit Service, Fort Worth, Texas
City Transportation Department, Pueblo, Colorado
Metropolitan Transit System, Kalamazoo, Michigan

Each property was interviewed by the authors. The Regional Transportation District, Denver, Colorado, and Metropolitan Transit System, Kalamazoo, Michigan, were visited for the purpose of on-site observation of fare collection operations, extensive interviews and interchange of ideas, and to personally observe the operation of specific equipment.

All others were interviewed by telephone. In addition, Mr. Joseph Koziol of the Transportation System Center, visited the Metropolitan Suburban Bus Authority, and the Southeastern Pennsylvania Transportation Authority.

To illustrate the operational problems and to focus the findings, it was determined that a particular fare collection system should be described in detail. It is not the intent to assert that the particular system is typical, but rather that it serve as a basis for discussion. Convenience, cost and willingness of the property led to the selection of the RTD, Denver, Colorado, as the system to serve as the basis of discussion.

RESEARCH RESULTS

This section presents, in narrative form, the results of our interviews with the various transit properties. Additional data from the properties in response to the questions in Appendix A are presented in Appendix B. In addition, this section also presents a description of the fare collection system employed by the Regional Transportation District, Denver, Colorado. This description is provided as background information to the Analysis and Discussion section which follows this section.

REGIONAL TRANSPORTATION DISTRICT (RTD)
DENVER, COLORADO

The following information was provided by Mr. Paul Prieb, Manager of Accounting, and Mr. Luigi Corbezzolo, Revenue Supervisor. They provided many insights into the fare collection problems in general, and those specifically caused by the dollar bill.

PROPERTY CHARACTERISTICS: The RTD operates 650 of 763 buses daily over a route structure that includes express, commuter, local, circulator and regional service. They have 680 fareboxes to support the requirement for 650 daily. The fare structure is $1.05 for express, 70¢ for peak hour local, 35¢ for off-peak local, and $1.75 for regional service. The system serves some 150,000 patrons daily during the week and 40 million annually. Responsibility for fare collection and counting, farebox maintenance and security of fares, resides with the Finance Department staff.

FARECOLLECTION METHODS: The fare collection system includes monthly passes and tokens sold by RTD, employers and retail outlets, as well as on-board cash collection. The latter includes 8,000 to 10,000 bills daily, which are manually sorted and stacked, and counted by machine. One full-time and three part-time employees accomplish this with the expenditure of 14 man-hours daily. Hence, a person sorts, stacks and counts between 570 and 715 bills per hour.

On board, token and cash collection is accomplished principally through the mechanism of what was originally intended to be an electronically registering farebox system. It no longer is. This feature was disconnected two year's ago because of reliability problems and the attendant high maintenance costs. The fareboxes display both coins and bills and dump them into a single rotating keyed vault.

EQUIPMENT MAINTENANCE: As a result of disconnecting the registration electronics, the 680 fareboxes are maintained by four people for a ratio of 170 fareboxes per maintenance person. This decision, and the results of experimentation with the configuration of the cash slot at the top of the box, road calls for farebox reasons have been reduced to the order of 1-2 per day. These are largely for jams caused by paper bills.

SECURITY REQUIREMENTS: Although acknowledging that increased use of the dollar bills makes large-scale loss in revenues due to theft more easily achievable, no special security procedures have thus far been implemented that were not in place previously. However, the estimated revenue loss of as much as 25 percent of total fare collections has led to the planning of a new money room wherein all employees will wear company provided pocketless clothes; money movement will be accomplished in a more orderly and visible manner.

FARE COLLECTION SYSTEM DESCRIPTION: Each of RTD's three metro garages is equipped with an automatic cash sorter for receiving money from the fareboxes. These are backed up by portable vaults, as shown in Figure 1. There are other collection points that use only the portable vaults. At the end of runs, the farebox vaults are manually pulled from each bus as it enters the garage (Figure 2A) and emptied into the cash sorter or portable vault (Figure 2B & 2C). This operation typically takes between 20 and 30 seconds, resulting in a considerable queue (Figure 3) at the end of the rush hour runs. The length of the queue reached 12 minutes the day we observed it, a length indicated as being average. In order to minimize the queue, buses in which problems occur in pulling the vaults are directed to a repair area.

Typical problems caused by bills are shown in Figure 4. It is not unusual for one or more bills to be exposed as shown in Figure 4A. This happens due to the gap between the inner vault wall and the sliding door being greater than the thickness of a dollar bill. If the bills are completely flat, as shown, they may get torn, or they may not end up in the properties account. If the entrapped bill(s) are folded, as shown in Figure 11A, a jam is likely to occur, resulting in the bus being pulled from service.

A second problem associated with farebox vaults that do not stack the bills, is shown in Figure 4B. The bills fall into the vault in a random fashion, as shown. If the fare structure is such that the fare consists of many bills and lightweight coins (pennies, nickels or dimes), one or more coins can slide along the bills to the outside of the vault and wedge between the sliding vault door and the inner wall of the vault. Coins can also jam between the outer vault wall and the farebox receiver when an attempt is made to close the vault door to remove it from the farebox (Figure 2A). This can make it impossible to remove the vault from the farebox by hand. Hence, a bus is pulled from service. Even if the vault is removed, a jam is possible when trying to empty it in the fare collection vault (Figure 2C). The reason for this jam possibility is the same as for the previous case; a light coin sliding across a bill due to the motion during vault transfer from the farebox to the fare collection vault.

The portable fare collection vaults are transferred to the property's money room from the collection points in the system. The money is transferred from them to containers via a gate in the bottom of the vault (Figure 5A). The combination of the low internal hopper floor angle and bills in the collections cause money to "hang up" in the vault. In order to ensure a completely cleared vault a mallet is used to strike the vault sides, Figure 5B, to dislodge any money not emptied from the vault. The mixture of bills and coins causes a further manual operation.

As the bills come out of the vault, coins slide over them and right over the sides of the container. This necessitates someone picking them up off the floor (Figure 5C).

These portable fare collection vaults, used to some extent by almost all properties, and almost exclusively by small and very small systems, are a labor intensive part of the money processing system.

Further, if the sorting machines used by the property cannot handle bills, these must be removed manually from the containers as shown in Figures 5A & 5C.

There are automated money separating machines on the market. The ones used by the RTD are shown in Figure 6. The particular ones they use have two vault openers, each individually keyed, on the left side of the machine as shown in Figure 6A. These door-mounted openers are shown in Figure 7. When the vault door opens it drops the money (bills, coins, and tokens) onto a moving, double-belt, money transport system on the left of the machine in Figure 6B. The money is raised to the top of the machine and deposited onto a horizontal moving belt at the top of the machine. As the money reaches the right side of the machine, the bills are "blown" off by a blower/vacuum system. This carries them to a bill bin in the bottom of the machine. The coins are deposited onto the vibrating coin sorting grid shown in Figure 8A. These grids have a slight angle to them. Hence, when a coin reaches the proper grid, it is transported to the low end of the grid and into the tube that transports it to a separate bin in the bottom of the machine. Some of the problems with the machine are shown in Figure 8. Under a heavy load of bills, not all are "blown" off at the proper point, resulting in bills riding on top of the coin grid as shown in Figure 8A. These bills block the coin sorting tubes causing bills and coins to backup along the grid. Eventually they overflow the sides of the grid and fall to the interior ledge over the money bins. This is shown in Figures 8B and 8C. This money must be retrieved manually and put back into the process or separately transported to the money room. On the day we observed the process, over $200 in bills were removed from this interior ledge.

The money is transported in separate bins to the money room (Figure 9A). Bills are removed manually (Figure 9B), and the segregated coins are put through the coin counting and bagging machine as shown in Figure 9C. This latter process is remarkably efficient as compared to the similar process for bills (Figure 10). Coins and tokens have been handled by machines for decades. The machines have evolved over that time and are quite reliable. The bill straightening, sorting, counting and matching of torn bills is almost totally a manual process.

RTD processes between 8,000 and 10,000 bills each day. The unfolding and sorting are completely manual operations, as are many of the processes preceeding this operation. Counting is accomplished on a manually-loaded machine (Figure 10). This process has been used in the banking industry for years. The machines are well developed and reliable.

There are additional problems in handling bills, as illustrated in Figure 11. People are fidgety.

While waiting for the bus, they fold, twist and manipulate the bill they are planning to use for the fare. If the bills don't jam in the entrance to the farebox, or in passage to the vault, they end up in the money room as shown in Figure 11A.

They must be straightened out, stacked and sorted before being counted. Considering the fact that drivers no longer make change, and that the maximum fare is $1.75 for inter-city service, the variety of bills shown in Figure 11B is somewhat amazing. It also adds to the bill sorting time. Other factors adding to these costs are the torn bill-matching time and separating out foreign currency implied by Figure 11C.

FIGURE 1

FARE COLLECTION VAULTS

FIGURE 1A

FIGURE 1B

FIGURE 2

PULLING AND EMPTYING THE
FAREBOX VAULTS

FIGURE 2A

FIGURE 2C

FIGURE 2B

WAITING IN LINE

FIGURE 3

FIGURE 4A

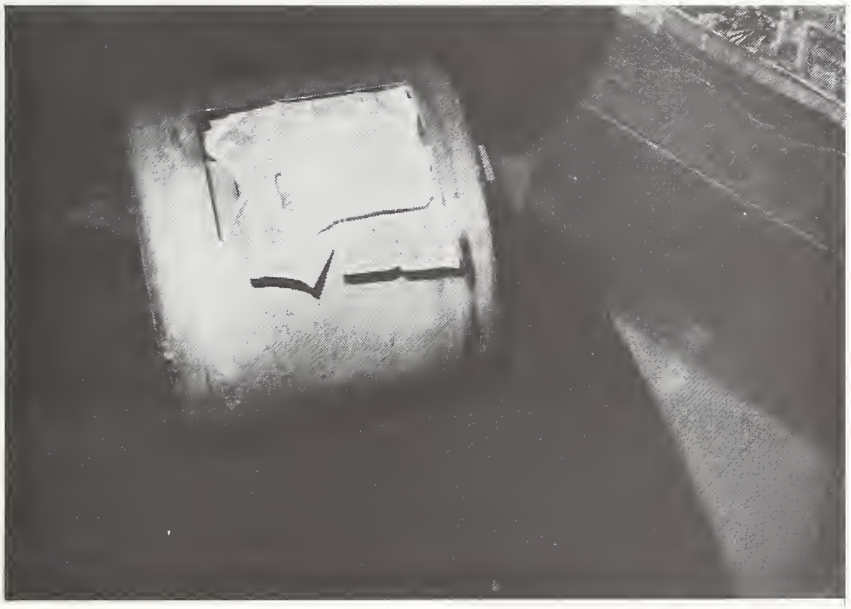

FIGURE 4B

EFFECTS OF BILLS IN FAREBOX VAULTS

FIGURE 4

FIGURE 5B

FIGURE 5A

FIGURE 5C

EMPTYING PORTABLE VAULTS IN THE MONEY ROOM

FIGURE 5

FIGURE 6

AUTOMATED MONEY SEPARATOR MACHINE

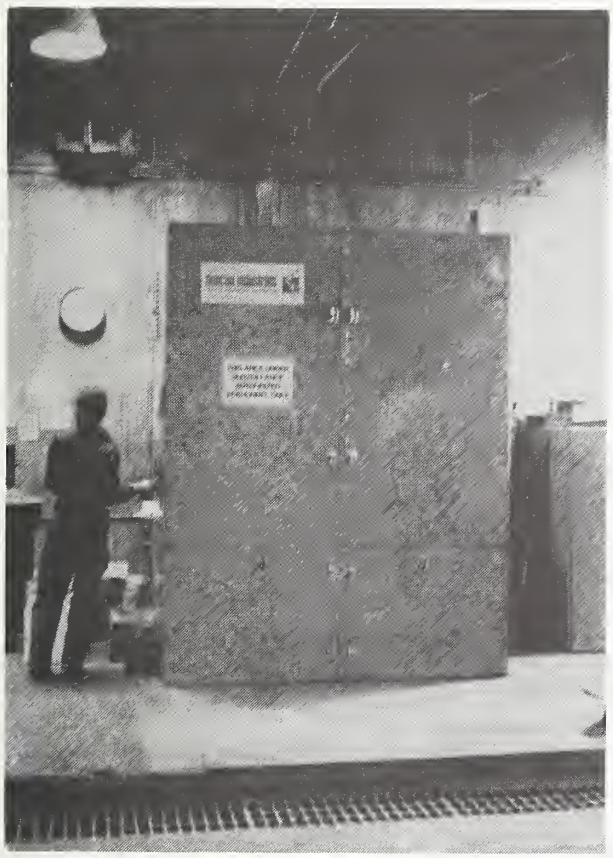

FIGURE 6A

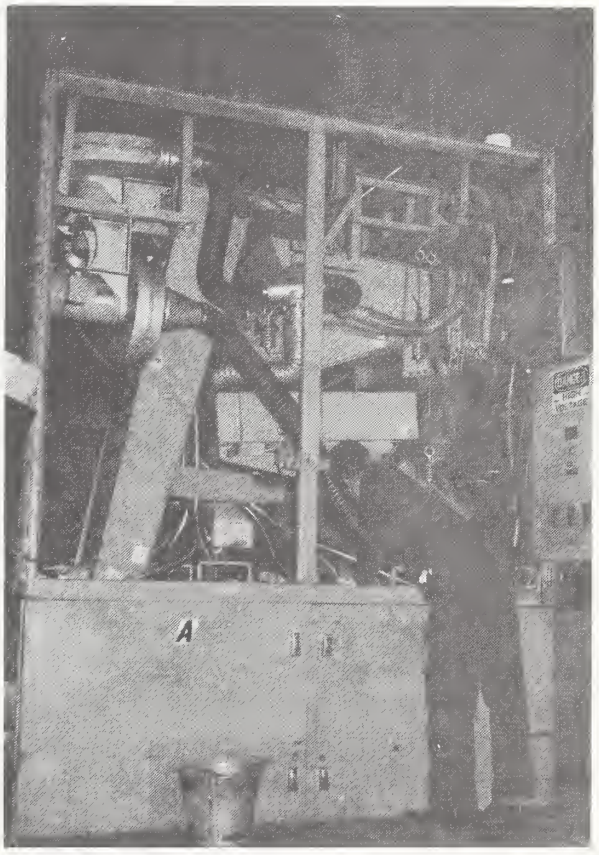

FIGURE 6B

FIGURE 7A

FIGURE 7B

FIGURE 7

FAREBOX VAULT
EMPTYING MECHANISM

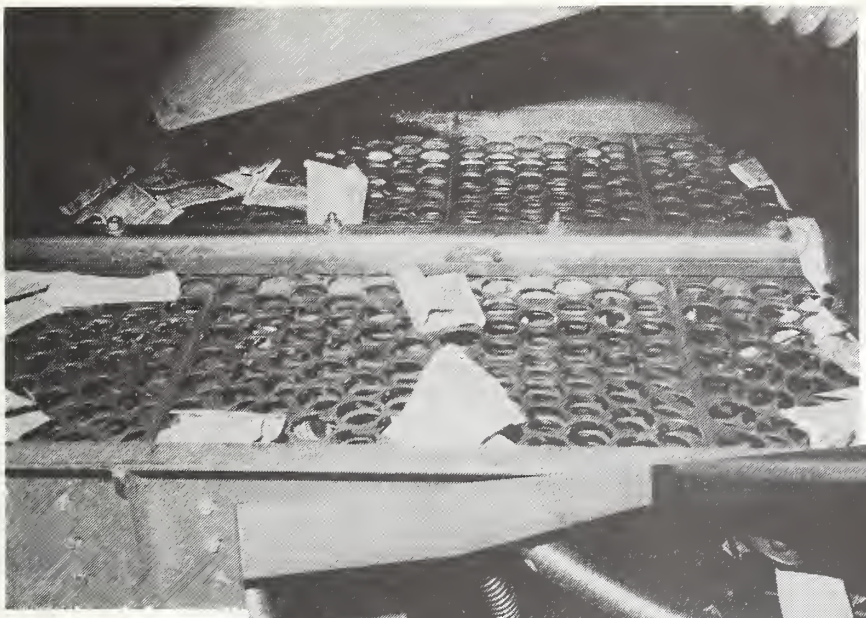

FIGURE 8A

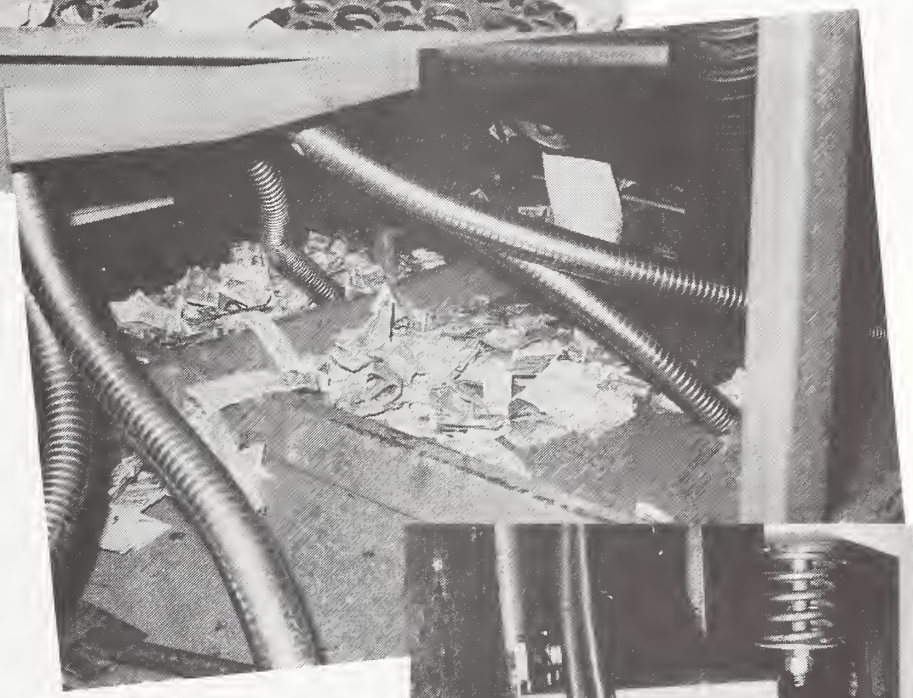

FIGURE 8B

FIGURE 8C

FIGURE 8

AUTOMATED MONEY SEPARATION
AND RESIDUES

FIGURE 9A

FIGURE 9B

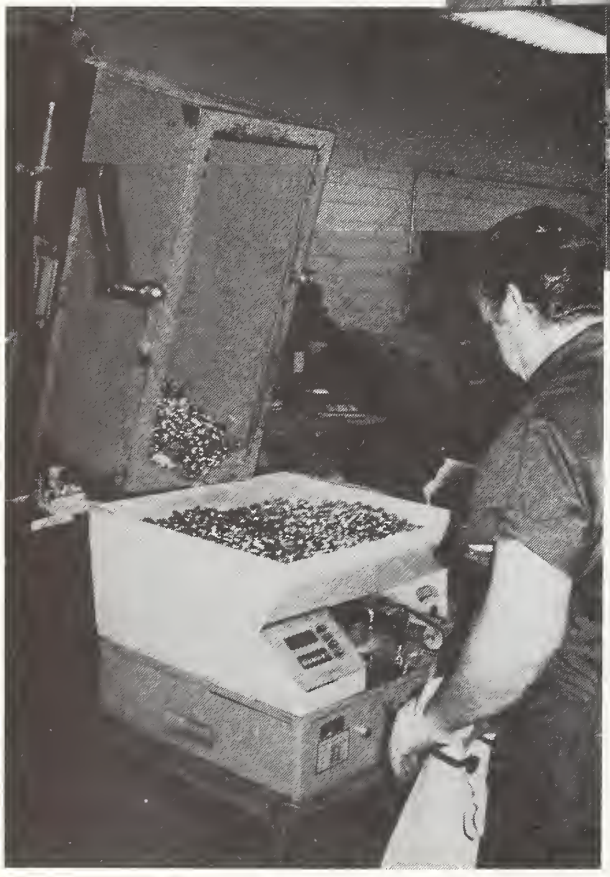

FIGURE 9C

FIGURE 9

HANDLING VAULTS FROM MONEY SEPARATOR MACHINES

FIGURE 10A

FIGURE 10B

FIGURE 10

SORTING AND COUNTING BILLS

FIGURE 11A

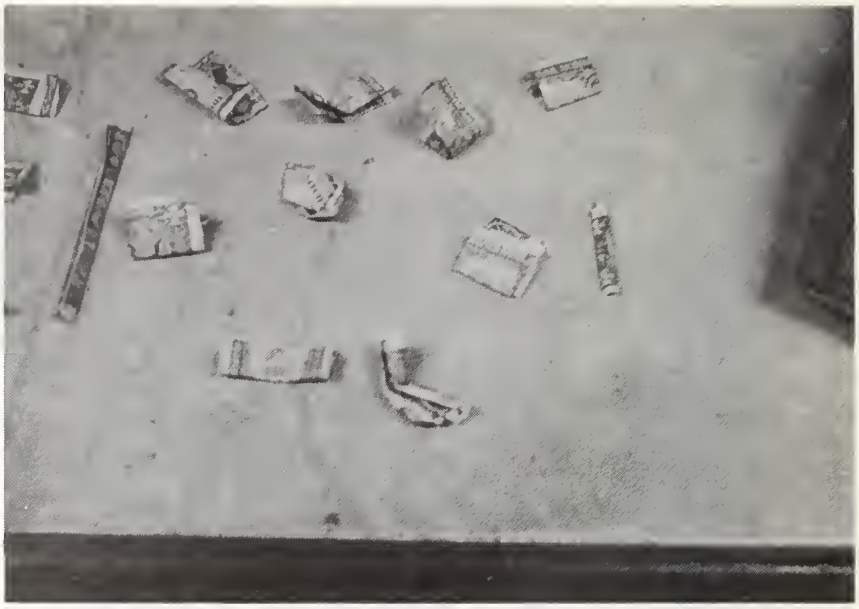

FIGURE 11B

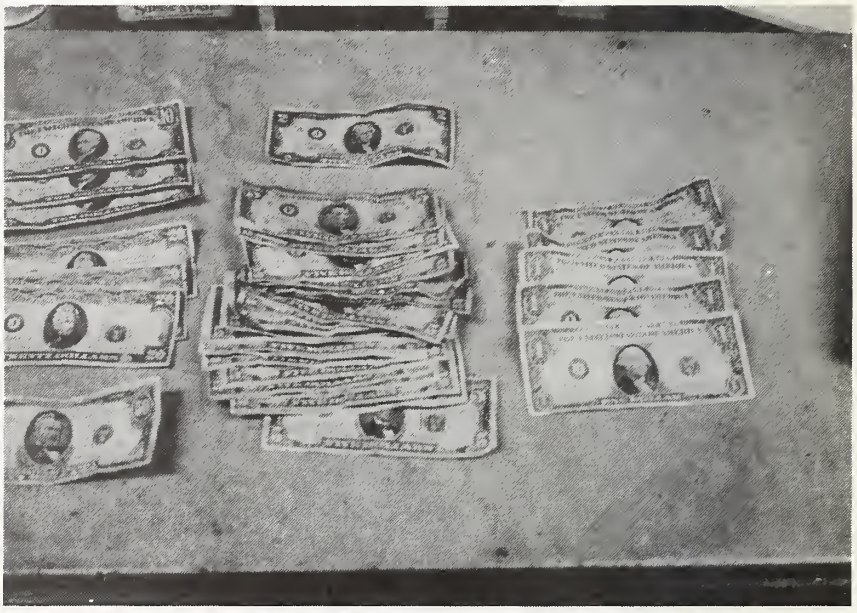

FIGURE 11C

TYPES OF BILLS
HANDLED AND CONDITION
OF BILLS

FIGURE 11

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY (MBTA)
BOSTON, MASSACHUSETTS

The following information was provided by Mr. Thomas Dunbar, Assistant Director of Bus Operations. The tables referred to are in Appendix B.

Table 1 indicates that the MBTA is able to operate registering fareboxes with only a 5 percent level of spare boxes. Table 2 shows a range of 8000 to 11,000 bills handled daily by three full-time people. Hence, each handles between 300 and 460 bills per hour--a rather high level of performance among those properties surveyed. In 1981, MBTA banned the bill by policy decision. The action was supported by MBTA's patrons and the number of bills handled daily was reduced dramatically. However, the number of bills has increased steadily since the fall of 1981.

The MBTA has tried innovative approaches in a couple of areas in the fare collection process. They sell tokens through vending machines with apparently very good success to date. Further, they've tried a novel approach to speeding up the dollar collection process at the bus.

Processing of dollar bills through fareboxes, even those designed to handle them is more time consuming than processing tokens and coins. In the morning where passenger boarding times are more spread out, (Park and Ride lots or enroute stops), this is not a problem. However, for evening express routes with passengers boarding from a relatively few stops and from significant queues, a considerable delay can be experienced. In an effort to speed things up, MBTA instituted a program last summer that collected for the round trip on the inbound trip. They are pleased with the program and believe it is accomplishing its objectives.

The eight full-time farebox maintenance personnel, listed in Table 3, yields a ratio of one person per 125 boxes.

SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY (SEPTA)
PHILADELPHIA, PENNSYLVANIA

The following information was provided by Miss Titus, Assistant Treasurer in charge of Revenue. The tables referred to are in Appendix B.

Like MBTA, SEPTA uses registering fareboxes that accept coins, tokens and bills. Their spare ratio is not known. Table 1 indicates that total responsibility for fare collection and counting, farebox maintenance and fare security rests in the Finance Department as it is with most properties surveyed. However, SEPTA only recently moved to maintenance function to finance, and feels it is too early to be able to tell if there's been an improvement in maintenance and accountability. It is instructive to note that SEPTA has subcontracted with the Brinks organization for fare collection and verification on the basis of an internal cost analysis.

The 27 farebox maintenance personnel shown in Table 3, means that 67 fareboxes are being maintained per person.

SEPTA's experience is that their fareboxes have a failure after a few hours of operation with an average MTBF of three to four hours. The problems center around the electronics and mechanical connections. These are manifested by inaccurate and unreliable counts because the LED displays either go out or jump in numbers.

As indicated in Table 3, SEPTA experiences between 8 and 12 outages per day. These are caused largely by the failure modes described above and by farebox jamming, largely from folded dollar bills. Such outages, by policy, result in bus pull-ins rather than road calls.

It should be noted that the above set of numbers (i.e., number of fareboxes in service, the MTBF and the number of road calls) appear to be inconsistent. They may or may not be, one cannot tell superficially--only with some examination of records. Suffice it to say, any actual experience even approximately that reported, indicates a need for basic changes in hardware, or in maintenance techniques. The potential for significant cost savings appears to be high.

The SEPTA people, as those with other properties, consider the lost revenue problem to be a very sensitive issue. However, they believe the range of 20-25 percent might not be out of line.

CENTRAL OHIO TRANSIT AUTHORITY (COTA)
COLUMBUS, OHIO

The information from COTA was provided by Mr. Donald Moore, Director of Operations. The tables referred to are in Appendix B. As indicated in Table 1, COTA is a much smaller property than the preceeding ones, and operates on a much simpler fare structure.

Fares are collected on board with manual fareboxes having no vaults. These fareboxes accept folded bills through the top. Their problems and costs from handling dollar bills reached such proportions that in 1981 they made a policy decision to lower the fare structure to the present levels in order to reduce the number of bills. In that the number of bills handled per day dropped by 67 percent, they were successful. The six man-hours per day required to sort, stack and count 800-1000 bills means that they handle between 130 and 170 bills per man hour.

Relative to Table 4, COTA could not venture an opinion as to the level of lost revenue. They did acknowledge "pilferage" problems that resulted in the hiring of an investigator. Employees were fired.

METRO-SUBURBAN BUS AUTHORITY (MSBA)
EAST MEADOWS, LONG ISLAND, NEW YORK

The controller of MSBA, Mr. John Gallagher, provided the following data. Although similar in size to COTA, this property has gone the route of the larger properties. They use one of the highest technology fareboxes available and believe it worth the price. Their box has separate vaults for coins and tokens, and for bills. Initially, they had many "bugs" with the fareboxes that were worked out with the manufacturer. In recognition of the type of equipment they were requiring, they adopted a stringent selection criteria for their maintenance personnel based upon specific electronic and mechanical skills. The individuals were then selected based on these criteria. No picks were permitted by the personnel. All personnel selected had previous experience with MSBA; all attended a training program sponsored by the manufacturer. This specially selected group has, according to Mr. Gallagher, a high level of discipline, morale, and sense of purpose. He cited as an example a case in which a maintenance person carelessly dropped and dented one of the boxes. He was fined for the incident--it has never happened again.

Table 2 indicates a normal handle of 3-4000 bills daily, requiring some 16 man-hours to sort and count. This indicates an ability to handle 190-250 bills per hour per person.

The six full-time farebox maintenance people indicated in Table 3 handle the 360 registering fareboxes at a rate of 60 boxes per person. At this maintenance level the box count is 99.9 percent accurate as determined from manual verification procedures. As with most properties, MSBA follows a policy of no road calls for fareboxes. People ride free until a replacement bus in put into service.

CITY TRANSIT SERVICE (CITRAN)
FORT WORTH, TEXAS

The follow information was provided by Mr. Gregory Podjan, Director of Operations. The tables referred to are in Appendix B.

Table 1 indicates a seven percent spare availability for their registering fareboxes. The five man-hours per day spent sorting and counting bills (Table 2) means that a person handles between 60 and 100 bills per hour.

The two full-time maintenance personnel handle 145 fareboxes for an average of 72 per person.

Although stating they had no figures, CITRAN thought their lost revenue was minimal.

TRANSPORTATION DEPARTMENT
PUEBLO, COLORADO

The following information was provided by Mr. John Bates, Director of Operations and Assistant Controller. The tables referred to are in Appendix B.

The ratio of the total number of fareboxes to those required for daily operation (60 percent) is the highest for any property interviewed. It is also interesting to note that to operate 21 buses daily they believe they need 25 operational fareboxes. This 19 percent spare ratio is substantially higher than the 5-7 percent ratios maintained by the other properties.

The low fare structure in Table 1 results in very low bill usage. As noted in Table 2, the 600-1000 bills handled annually cause few problems.

Pueblo reported significant reliability problems with their electronically-registering fareboxes. As with SEPTA, a major problem was with the connectors. This property is unique in one regard. The farebox maintenance person is a degreed Electronic Engineer. Assuming the gentleman is as capable as those at other properties, he should be able to maintain more fareboxes than the property owns. In fact, he has put the time to good use and modified the farebox electronics both to reduce maintenance requirements, and to have the farebox electronics interface with a microprocessor chip that gives daily updates of the ridership by route.

As with other small properties it is not believed that the revenue loss is significant although there is no specific data.

METRO TRANSIT SYSTEM
KALAMAZOO, MICHIGAN

The purpose of the visit to this property was to observe their ticket reading and cancellation demonstration system, and discuss its operation with property personnel. Discussions were held with Miss Debbie Danhoezen, Marketing Coordinator, who is responsible for the demonstration project, and Messrs. Terry Cooper and Bill Schomish, respectively, the General Manager and Operations Manager.

PROPERTY CHARACTERISTICS: Under the definitions used in this study, Metro Transit is a very small system. It serves between 12,000 and 13,000 passengers per day, of which 2000-3000 are estimated to be college students. The fare structure is 50¢ per trip (there are no zones), and 25¢ for the elderly and handicapped. There is also a free fare period between 10:00 a.m. and 3:00 p.m. two days a week. Fares are collected via cash in the farebox, passes, tokens, and the ticket demonstration program, which was the purpose of our visit. The fare structure results in few dollar bills; 400-600 being handled per day.

DEMONSTRATION SYSTEM: Metro Transit's main interest in the ticketed demonstration system is that it offers the potential of an accountable fare collection system. Their estimate of their lost revenue from their normal fare collection system is between 15 and 25 percent of total fares. Even with the few dollar bills they handle, they cited the case of a driver who was caught with a number of marked bills in his pocket. One of their main interests in the demonstration project was to try a "closed loop system" in an attempt to curb loses.

The demonstration system consists of tickets (Figure 12), a reading, recording and cancellation machine located on the bus (Figures 13 & 14), and a ticket vending machine (Figures 15 & 16). The ticket is good for eight rides, with the number of remaining rides being indicated on the left side of the ticket (Figure 12A). On entering the bus, the ticket is inserted into the reader/cancellor and either verified as good or rejected. The reader checks two criteria: the code embedded in the magnetic strips (Figure 12B) and the number of trips remaining. If verified, a guillotine cuts off a ride tab, the counter (Figure 13A) turns over and the machine "noise signature" indicates a valid ticket. If the code is incorrect, or there are no rides left, a buzzer sounds indicating an invalid ticket to the driver and all patrons.

The reader/cancellor is a small unit mounted next to the farebox. Mounted on a short tube stub, it is easily removed for maintenance as shown in Figure 14A. In use for sometime in Europe, the particular unit they've installed has proven to be very reliable.

The ticket vending machine is a new development for this program. Bills ($5) are inserted into a standard bill reader and stacked on the interior of the machine door (Figure 16A). This activates a set of solenoids that results in two tickets being dispensed; these are good for 16 rides.

Tickets are stacked in a spring-loaded elevator with the top ticket (Figure 16B) being dispensed by a jet of air provided by the compressor on the floor of the machine.

Initial problems with the dispenser, since corrected, involved regulation of the air pressure at a sufficient level to lift the ticket off the stack. They reported no electronic problems.

SYSTEM PROBLEMS: Two problems are being experienced with the system. One is that movie ticket stubs inserted into the ticket readers can cause jams. The second is a loss of ticket strength when folded, as shown in Figure 12, in order to fit it into a wallet. The loss in strength keeps one from inserting the ticket far enough into the reader to obtain the last valid fare. Moving the fold to a higher position on the ticket solved the problem with the few tickets we tried.

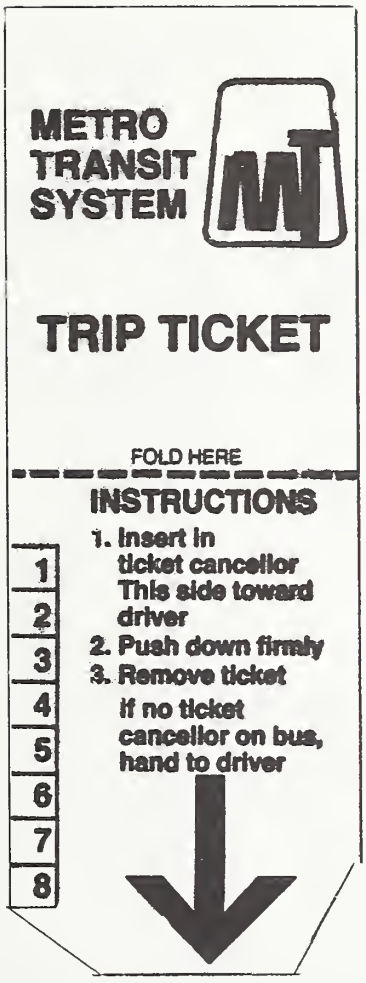

FIGURE 12A

FIGURE 12B

KALAMAZOO DEMONSTRATION SYSTEM
TICKET

FIGURE 12

FIGURE 13A

FIGURE 13B

ON BOARD TICKET READER AND
CANCELLOR

FIGURE 13

FIGURE 14

READER/CANCELLOR ASSEMBLY
AND REGISTRATION

FIGURE 14A

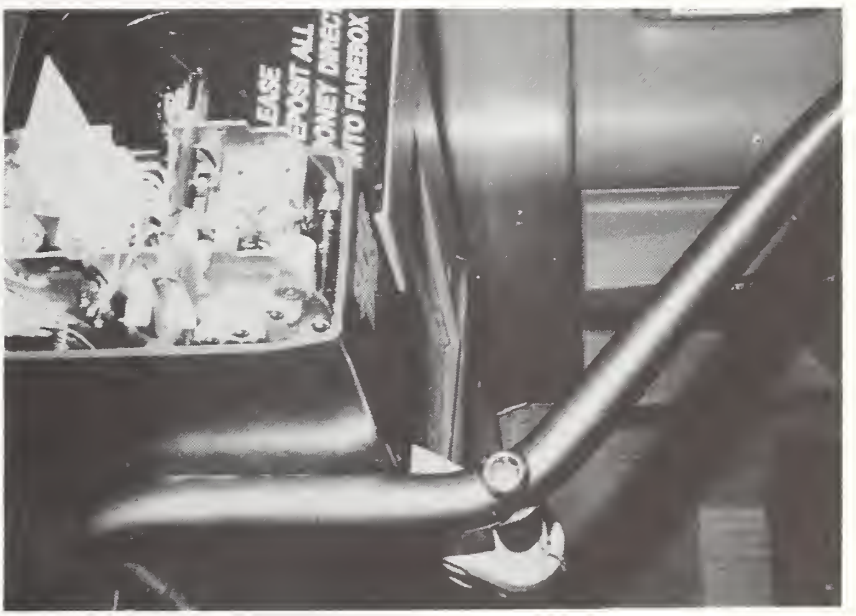

FIGURE 14B

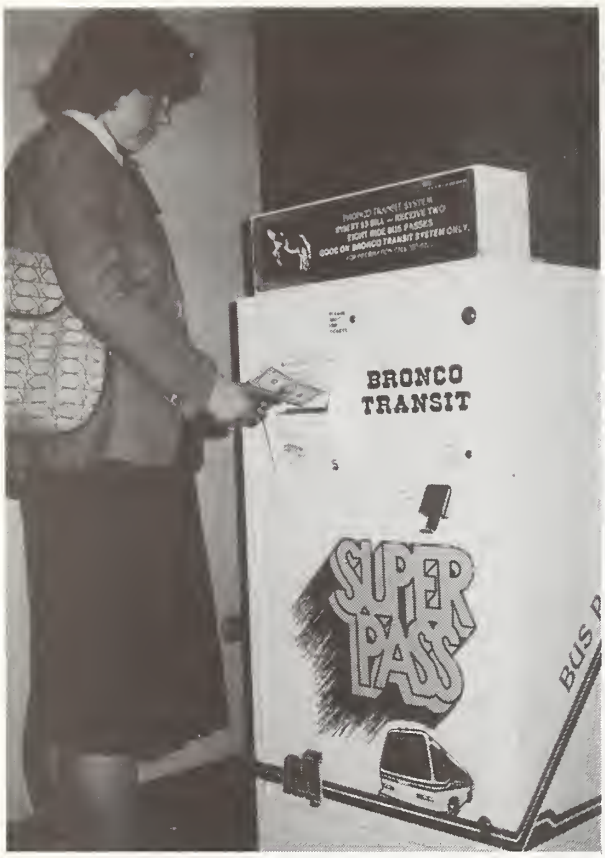

FIGURE 15

TICKET VENDING PROCESS

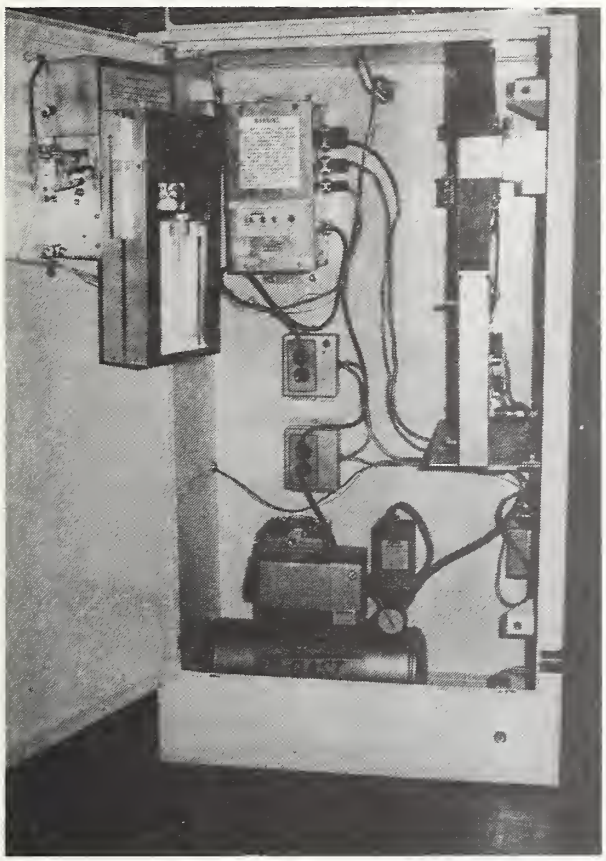

FIGURE 16

TICKET VENDING MACHINE

FIGURE 16A

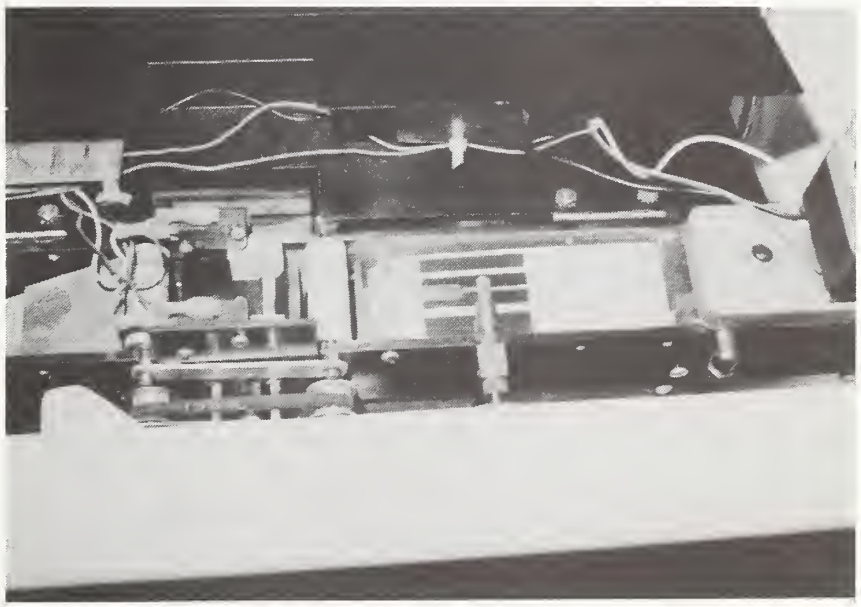

FIGURE 16B

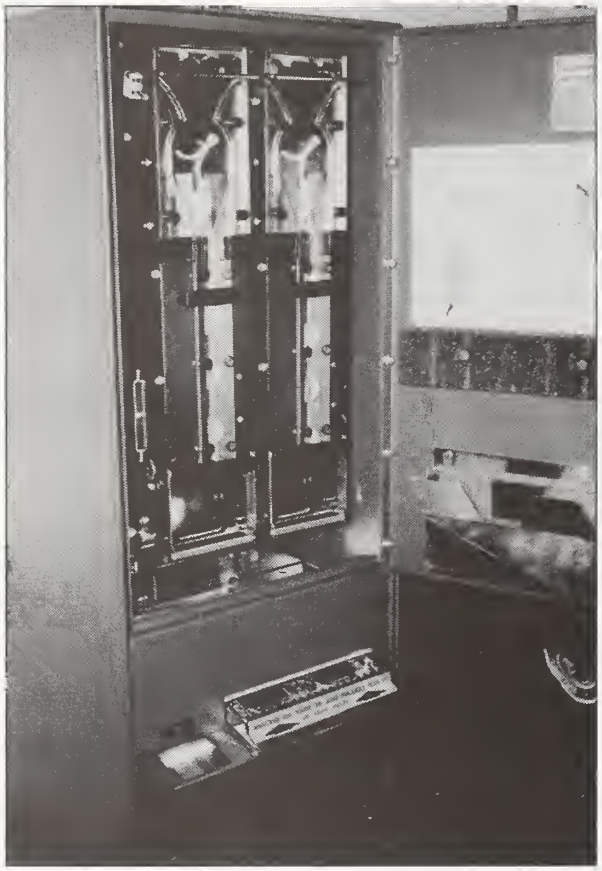

FIGURE 17

TOKEN VENDING MACHINE

ANALYSIS AND DISCUSSION

Bill handling problems do exist in bus fare collection systems. The problems are significant. Properties are striving to deal with them, and when the subject is broached, emotions run high. Through all of the emotions three broad problems emerge. These are:

- Equipment Reliability and Maintenance
- Bill Handling Costs
- Lost Revenue

Each of these will be discussed separately.

EQUIPMENT RELIABILITY AND MAINTENANCE: Without exception, the properties that have electronically registering fareboxes experienced difficulties with them when they were introduced into service. The problems centered largely around the electronics and the electrical connectors to the boards. There were other problems. By and large, the properties believe they did not receive proper supplier support and cite excessive costs for spare parts. The extreme reactions to this problem were in Denver and Pueblo, Colorado. Each took a different tack. Denver RTD disconnected the farebox electronics in frustration over the situation. They also designed and fabricated their own funnel for accepting dollar bills in an effort to reduce the number of jams caused by dollar bills. Pueblo, on the other hand, hired an electronic engineer to maintain the fareboxes. As noted earlier, he had time to address the larger system problem as well as provide day-to-day maintenance. He made some modifications to the electronic subsystem to make it more reliable. He also made modifications to make the output more productive. Their approach may well portend the future.

As discussed in the description of the fare collection problem, rotating farebox vaults jam with some degree of regularity when bills and coins are mixed in the same vault. These jams are freed, more often than not, by the use of manual, high leverage devices (e.g., crowbars). The net result is usually a heavily damaged vault or farebox. We could not evaluate these costs--there was no data available.

If technology is going to be used in the transit industry to increase productivity, as it is being used in other industries, the whole process must be attuned to that direction; i.e., the property, the supplier, and the system hardware. Properties cannot long employ sophisticated technology without needed access to competent engineers and technicians trained in the technology being used. Suppliers who do not support their products in the field in a timely manner, and hardware that does not function in the environment in which it must operate, only serve to prolong the productivity problems associated with fare collection.

Transit properties with 170 or more fareboxes to maintain must today increase their farebox maintenance staff by between 250 and 300 percent if they use registering fareboxes. In the case of the RTD in Denver, this difference would amount to some $200,000 per year in maintenance costs. If registration is useful to a property, it would seem that some increase in capital cost could be justified if that is what it takes to reliably reduce long-term maintenance costs.

BILL HANDLING COSTS: The costs of handling bills is multi-faceted. It includes capital as well as labor costs for all but the smallest properties. One property apparently evaluated the total system costs and decided the benefits could not justify the costs. They lowered their fare structure to reduce their bill handling costs. Other properties have banned the bill. Both are temporary solutions at best. The table below summarizes the expense in terms of bills handled per person per hour in sorting, stacking and counting bills. It was arrived at by a simple averaging process.

BILLS HANDLED DAILY	BILLS/PERSON/HOUR-AVERAGE
Up to 1,000	80-150
3,000 to 11,000	220-460

The table excludes the data reported by the RTD in Denver.

The 640 bills handled per person per hour, reported earlier, is significantly higher than that reported by any other property. Having observed their operation, this figure appears reasonable for handling the large pile in Figure 10A, neglecting the hand transfer time shown in the Figures, the time spent unfolding bills and that spent matching torn bills. All are required operations in handling bills. Hence, it is believed the other properties' data is more representative of the cost of handling dollar bills.

The two-to-one variation in performance in each category is indicative either of actual performance variations, lack of reliable data, or both. In any case, it is felt that the difference between the two sets of numbers is attributed to amortization of supervision for the process. Using the higher range as indicative of personnel performance means that on the average, one person will process a bill every 8-16 seconds. Given the number of bills that must be unfolded, the number of torn bills that must be matched, and the number of other hand operations in handling the bills, this range does not seem unreasonable. Assuming average labor rates for the industry, the table above indicates that the cost of handling bills probably varies between 2¢ and 10¢ per bill, with the present technology. Even the lower number, 2¢, is a high price to pay.

Assuming that the data acquired in this research is representative of the country, the results presented in the two Tables above are rather enlightening. The properties surveyed that use electronic registering fareboxes have a farebox maintenance staff that is approximately 250 percent larger than the staff employed by properties with non-registering mechanical fareboxes. Is the cost worth it? Only the individual property can answer. However, some discussion of options might be useful.

Further, properties should focus more of their attention on the fare collection system, and not on just one piece of hardware in the system. To cite a specific example, most of the problems reported by the properties centered about the farebox's ability to function in a bus environment. That is, the vibrations and shock loads imposed by pot-holes, road repairs, poorly maintained shock absorbers and significant differences in driving habits. Further, the humidity under which the equipment operates varies from the few percent in a southwest summer to the 90 percent level in the southeast. The temperature at the farebox can vary from the low teens when the door is open in a Buffalo winter, to ten times that in a non-air conditioned southern system in July. Though mechanical fareboxes with wide tolerances were developed over time, and operate quite satisfactory in this environment from a reliability and maintenance point of view, the same has not yet happened with electronic registering fareboxes. Given time, it will happen with properties paying a high price for maintenance.

There is a more positive approach that can be taken to protect those foreward looking properties who are willing to introduce new technology in their drive to increase productivity. That is for the Federal government, the largest purchaser of the equipment, in conjunction with all elements of the industry, to define the environment in which the equipment must be capable of operating. Then, manufacturers that intend to make and sell the equipment should be required to demonstrate that their equipment operates successfully in the defined environment (an analogy to a UL approval for consumer electrical equipment). In view of the small number of suppliers in the industry, it might well be cheaper for the government to pay for such an equipment certification test than to pay for the high cost of maintenance, as they now do. the properties, for their part, need to have the proper level of technical skills assigned to maintain the equipment. MSBA seems to have worked that problem extremely well and is pleased with the result.

It is also true that properties need to think through both the intended benefits and the costs of technological advances. Technology tends to be costly and is justified solely if it improves productivity. In this regard, the following table is instructive:

TYPE OF FAREBOX	NO. OF PROPERTIES	FAREBOXES MAINTAINED PER MAINTENANCE PERSON
Non-Registering	2	170-175
Registering	3	60-70

It should be noted that two properties fell outside the 60-70 range for registering fareboxes. One was a small property having fewer than 60 fareboxes and one maintenance person. He did other things besides maintenance, as reported elsewhere. However, they declined to estimate the pure maintenance time. The other property's data indicated one person could maintain 125 registering fareboxes. We could not reconcile this difference as they have a mixture of registering and non-registering fareboxes in their system. It is believed that the table is representative of the difference in maintenance requirements between extant registering and non-registering fareboxes. It is significant!

POTENTIAL SOLUTIONS: There are four rather obvious ways to generate benefits to cover the higher capital and maintenance costs of registering fareboxes. First, and foremost, is to modify the design, including parts used, so that maintenance costs are substantially reduced. Some increase in capital cost might even be justified to accomplish and demonstrate the reduced maintenance requirements. This solution implies that demonstrated life cycle costs be used as a major factor in manufacturer selection.

A second solution is to speed up the bill handling process by an order of magnitude, e.g., process 4000 bills per person per hour, or just over one per second. This should be feasible if registering fareboxes reliably stacked the bills in a separate vault. If this stacker were the magazine for the bill counting machine, and if the farebox/stacker system is reliable, the system would essentially eliminate the manual bill sorting and stacking process (Figure 10A), and the manual transfer from bins (Figures 9A & 9B).

Further, elimination of the bills from the coin sorting machine (Figure 8) not only increases productivity in bill handling, but increases coin handling productivity. Whether or not the increase in money handling productivity would be the order of magnitude necessary to pay for the present higher costs of bill accepting electronic registering fareboxes is speculative; that it would provide a major increase in productivity is self-evident.

A third solution is to use the electronic registration feature to provide the necessary patronage data to increase the bus system productivity through better route and service planning. In this regard, the Pueblo, Colorado Transportation Department is by far the most advanced of all the systems surveyed. As presented to us, they have directly interfaced the registering farebox electronics with a microprocessor to produce a daily printout of individual bus route productivity. If correct, the Pueblo people have provided a good example of how an imaginative engineer can apply modern technology to increase a transit system's productivity--as it is being done in other industries.

The most desirable approach is one that encompasses all three solutions, i.e., a "systems approach."

LEVEL OF LOST REVENUE: Perhaps the most surprising finding of this research is the amount of revenue most of the properties surveyed believed they should be getting--but are not. This is obviously a sensitive subject and one in which there appears to be little hard data. The opinions on this subject, of the properties surveyed, are summarized in the table below:

LOST REVENUE / DEPOSITED REVENUE (PERCENT)	NO. OF PROPERTIES
Minimal	2
10%-15%	1
15%-20%	3
As high as 25%	2

Given that there is some validity to these estimates, potential savings from a better fare collection system could be enormous. APTA's Transit Fact Book, 1981, indicates in Table 8 that passenger revenue from trolley coaches and motor buses in 1980 came to $1.8 billion. If the 15 to 20 percent estimate of lost revenue is anywhere near right, the lost revenue from trolley coaches and motor buses in 1980 was between $270 and $360 million. To put these in perspective, these figures represent, respectively, 25 and 33 percent of the Federal Operating Assistance provided to all transit properties, including rail systems, in 1980 (ibid. Table 5). There are many factors that contribute to lost revenue. At crowded bus stops people board the bus either in front or via the rear door, and do not pay for their trip. Passes are torn in half. Each half is placed in a different individual's wallet to be flashed at the driver on entering the bus. Further, monthly passes are also counterfeited. None of these avenues of lost revenue are directly related to bill handling problems in bus fare collection systems. Therefore, they will not be discussed further except to opine that to the extent they exist, it is likely that these avenues will increase as fare structures increase inexorably towards the $1 level.

The dollar bill itself contributes to revenue pilferage or theft because of its high value per ounce, its ease of concealment and the difficulty of handling it with much of the fare collection equipment currently in use. Consider some examples. One property with a fare structure above $1 was experiencing rather severe reliability problems with their registering fareboxes. At least one driver seized the opportunity and taped a collection envelope to the farebox with a note to "deposit fares here--the farebox still doesn't work well." Their system did not notice the revenue shortfall. An alert passenger did. Another property with older manual boxes reported long tweezers being used to lift $1 bills from the boxes during layovers. The dollar spillover shown in Figure 8B, which came to $200, offers opportunity for theft, as does the manual bill handling processes shown in Figures 9, 10, and 11. Unmatched torn bills (Figure 11C) represent further lost revenue. Folded bills, Figure 11A, are not always complete bills, Often they are less than "legal tender" size.

The variety of bills in Figure 11B is instructive. A $50 dollar bill should never show up--but it obviously did. It was surmised that a traveler without any change boarded a regional service bus at the airport. Contrary to policy, the driver made change by the simple expediency of hand collecting fares, also against the rules, from subsequent passengers until he had the right change and then deposited the $50. In this case the driver accommodated a grateful passenger. This same approach could lead to other results.

One of the significant factors leading to "lost revenue" is that the fare collection system is not a "closed system." Electronic registering fareboxes that are easily programmable to the daily time variation in rate structure and readily interfaced with the revenue accounting system would be a major step forward. If such a system were implemented, as against just having registering fareboxes, it would permit daily comparisons between revenue collected and revenue deposited. This at least would provide a "closed system,"once a fare had been registered.

The addition of passenger counters could potentially provide the desired "closed system." Another, and conceivably more attractive approach, is to remove the money collection function from the buses. A system, such as that being demonstrated in Kalamazoo, has that potential. Tickets sold through vending machines provide a closed system of accountability. Those sold through outlets--including the transit property, offer opportunity for human ingenuity and lost revenue. However, it would be a significant improvement over the present situation.

Tokens are reuseable. Hence, the problem of the "float" exists in attempting to achieve strict accountability.

There undoubtedly are other approaches to this problem than just those proposed. What seems to be more important than any particular approach, is the level of lost revenue estimated. If the estimates provided to us by the properties are even close to being correct, an investment of approximately 10 percent of the estimated lost revenue should provide for the demonstration and evaluation of two or three approaches on a significantly sized basis. If one was found to be effective in reducing lost revenue, it could probably be implemented on most of the operating buses in the country for the cost of one-year's loss.

Perhaps the right starting point is to determine factually if the estimates of the lost revenue are anywhere near right.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions derived from this research into the bill handling problems experienced in bus fare collection systems are:

1. The bill handling process is largely a cumbersome, costly, manual operation at the properties surveyed.

2. Bill handling costs are estimated to be between 2¢ and 10¢ per bill handled.

3. Registering fareboxes at these properties require 2-1/2 to 3 times the maintenance staff that non-registering fareboxes require.

4. Lost revenue is caused by a number of factors including theft.

5. Removing the money collection function from the bus would increase fare accountability and reduce lost revenue.

6. There are ticket vending and onboard reading and cancelling systems that offer this capability, as well as the potential for lower operating costs.

Recommendations from this research are:

1. A program should be initiated to get a better idea of the level of lost revenue bus systems are experiencing. The intent is to provide more insight into the problem and its extent. If it is at the level postulated, a significant inroad into its solution(s) would enhance operating revenue nationally.

2. The reliability problem and attendant high maintenance cost of electronic registering fareboxes should be addressed head-on with both the properties and the suppliers. As part of this, an operating environmental specification should be developed that farebox designs would have to pass before being introduced into the marketplace for Federal funding. Lack of such an approach has cost the American taxpayers untold millions of dollars in maintenance costs in this instance alone.

3. A total "system approach" should be developed for handling dollar bills. It should be demonstrated on a significant scale. Two approaches should be considered for development:

   a) One with bills collected onboard,
   b) the other, with all fares collected off the vehicle.

System requirements for both developments might be that the bills be accepted, automatically stacked, and then the portable stacker with the bills should be removed in a locked vault. The stacker when removed from the vault could interface directly with the counting machine. This machine would automatically count and wrap the bills and eject them into a bank money bag. The onboard system would be developed to interface with existing electronic registering fare-boxes to the extent possible. The onboard equipment should be designed to operate in a bus environment.

An off-vehicle ticket vending machine and a vehicle ticket reading and cancelling system such as that being demonstrated in Kalamazoo should be further demonstrated in a larger urban system. To protect against theft, the bill stacker should be secured on removal and interface directly with a bill counter. The ticket magazine should also be made to secure the tickets against theft.

4. As part of a "systems approach," consideration should be given to interfacing the registering electronics with a microprocessor at an urban transit system. The objective is to increase productivity in two areas. First, to increase fare collection productivity, i.e., reduce lost revenue, by providing a closed system for accounting for all of the money that actually went into the farebox. Second, to determine the effectiveness of extant routes in a timely manner.

APPENDIX A

QUESTIONS

The following questions were used as the basis for telephone interviews with the various properties. They cover four areas of information relevant to fare collection problem definition: property characterization questions designed to define the property; fare collection methods to determine the methods of collection, sorting and counting as well as the equipment used in fare collection; equipment maintenance--what added requirements, procedures and costs have been caused by the dollar bill; security requirements--what requirements, procedures and costs have been added because of the more prevalent use of the dollar bill.

The specific questions developed are listed below:

PROPERTY CHARACTERIZATION:

- Number of Operational Buses
- Daily Passenger Count
- Fare Structure
- Organizational Responsibility for
  -Fare Sorting and Counting
  -Farebox Maintenance
  -Security of Fares

FARE COLLECTION METHODS:

- Types of Fare Used
- Methods of Fare Collection
- Number of Paper Bills Handled Daily
- Method of Bill Sorting, Stacking and Counting
- Cost of Bill Sorting and Counting
  -Number of People Required
  -Lenght of Time Required

EQUIPMENT MAINTENANCE:

- Increase in Road Calls, or in Shop Maintenance Caused by Dollar Bills
- Added Procedures, Personnel and Costs Caused by Increased use of Bills

SECURITY REQUIREMENTS:

- Added Security Procedures or Modifications Caused by the Increased use of Bills

- Added Costs of these Procedures
  -Number of People
  -Time Required

- Level of Theft/Loss of Revenue Estimated for the Property
  -Has it Increased Because of the Greater use of the Dollar Bills

APPENDIX B

DATA FROM PROPERTIES

This section presents a compilation of the data collected on the questionnaire from the individual properties. Much of the data is presented in ranges, indicating either a daily variation or a lack of precise data. The latter is very prevalent in this area. Interviews with two properties, The Regional Transportation District, Denver, Colorado, and The Metro Transit System, Kalamazoo, Michigan, are more extensive than the others. These were conducted on-site; the others via telephone. Some of the questions could not be answered by the properties. They had no data.

MASSACHUSETTS BAY TRANSPORTATION AUTHORITY (MBTA)
BOSTON, MASSACHUSETTS

TABLE 1 - PROPERTY CHARACTERISTICS

- BUSES - 1200 Total/950 Operational Daily
- FAREBOXES - 1000 Total/950 Operational Daily
- PASSENGERS (1981) - 156 Million Total/650,000 Daily
- FARE STRUCTURE - $1.50 Express, 50¢ in Town
- ROUTES WITH FARES $\geq$ $1.00 - 40 percent
- ORGANIZATIONAL RESPONSIBILITY
  -Fare Sorting and Counting
  -Farebox Maintenance
  -Security of Fares

TABLE 2 - FARE COLLECTION METHODS

- TYPES OF FARES AND METHODS OF COLLECTION
  -Cash - Electronic Registering Fareboxes
  -Tokens - Electronic Registering Fareboxes
  Sold through Vending Machines
  -Passes - Sold through MBTA and Employers
- BILLS HANDLED DAILY - 8,000-11,000
- METHOD BILL SORTING, STACKING AND COUNTING
  -Manual Sorting and Stacking
  -Machine Counting
- COST OF BILL SORTING, STACKING AND COUNTING
  -Number of People - Three
  -Length of Time - Twenty-four man hours per day

TABLE 3 - EQUIPMENT MAINTENANCE

- FAREBOX MAINTENANCE PERSONNEL - Eight full-time Personnel
- FAREBOX-CAUSED ROAD CALLS - All Buses Pull-Ins
- ADDED PROCEDURES AND PERSONNEL CAUSED BY DOLLAR BILLS - N/A

TABLE 4 - SECURITY REQUIREMENTS

- ADDED PROCEDURES CAUSED BY DOLLAR BILLS - None
- ADDED COST OF PROCEDURES - None
- LOST REVENUE - 15-20 percent

SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY (SEPTA)
PHILADELPHIA, PENNSYLVANIA

TABLE 1 - PROPERTY CHARACTERISTICS

- BUSES AND TROLLEY - 1800 Total
- FAREBOXES - 1800 Total
- PASSENGERS (1981) - 1.6 Million
- FARE STRUCTURE - $2.00 Regional, 75¢ Express, 60¢ City
- ROUTES WITH FARES $\geq$ $1.00 - 10 percent
- ORGANIZATIONAL RESPONSIBILITY
  - -Fare Sorting and Counting - Assistant Treasurer in Charge of Revenue
  - -Farebox Maintenance - Assistant Treasurer in Charge of Revenue
  - -Security of Fares - Assistant Treasurer in Charge of Revenue

TABLE 2 - FARE COLLECTION METHODS

- TYPES OF FARES AND METHODS OF COLLECTION
  - -Cash - Electronic and Mechanical Registering Fareboxes; separate slot for bills
  - -Tokens - Electronic and Mechanical Registering Fareboxes Sold through Vending Machines and other Outlets
  - -Passes - Sold through SEPTA and Employers
- BILLS HANDLED DAILY - 10,000-11,000
- METHOD BILL SORTING, STACKING AND COUNTING
  - -Machine Separation from Coins
  - -Manual Sorting and Stacking
  - -Machine Counting
- COST OF BILL SORTING, STACKING AND COUNTING
  - -Number of People - One, SEPTA
    - Five, Brinks
  - -Length of Time - Eight man-hours per day, SEPTA
    - Forty man-hours per day, Brinks

TABLE 3 - EQUIPMENT MAINTENANCE

- FAREBOX MAINTENANCE PERSONNEL - Twenty-seven
- FAREBOX-CAUSED ROAD CALLS - Eight to Twelve per Day (all Pull-Ins)
- ADDED PROCEDURES AND PERSONNEL CAUSED BY DOLLAR BILLS
  - -Four Maintenance Personnel
  - -Two Revenue Personnel

TABLE 4 - SECURITY REQUIREMENTS

- ADDED PROCEDURES CAUSED BY DOLLAR BILLS - N/A
- ADDED COST OF PROCEDURES - N/A
- LOST REVENUE
  -Unappropriated Funds are significant

CENTRAL OHIO TRANSIT AUTHORITY (COTA)
COLUMBUS, OHIO

TABLE 1 - PROPERTY CHARACTERISTICS

- BUSES - 322 Total/239 Operational Daily
- FAREBOXES - 252 Total/232 Operational Daily
- PASSENGERS (1981) - 21 Million Total/81,000 Daily
- FARE STRUCTURE - 60¢ Express, 50¢ Local
- ROUTES WITH FARES $\geq$ $1.00 - None
- ORGANIZATIONAL RESPONSIBILITY
  -Fare Sorting and Counting - Finance
  -Farebox Maintenance - Finance
  -Security of Fares - Finance

TABLE 2 - FARE COLLECTION METHODS

- TYPES OF FARES AND METHODS OF COLLECTION
  -Cash - Manual Fareboxes
  -Tokens - None
  -Passes - Tickets are like money--goes into Fareboxes
  Sold through COTA
- BILLS HANDLED DAILY - 800-1,000
- METHOD BILL SORTING, STACKING AND COUNTING
  -Manual Sorting and Stacking
  -Manual Counting
- COST OF BILL SORTING, STACKING AND COUNTING
  -Number of People - Two
  -Length of Time - Six man-hours per day

TABLE 3 - EQUIPMENT MAINTENANCE

- FAREBOX MAINTENANCE PERSONNEL - One
- FAREBOX-CAUSED ROAD CALLS - Don't believe there are any
- ADDED PROCEDURES AND PERSONNEL CAUSED BY DOLLAR BILLS - None

TABLE 4 - SECURITY REQUIREMENTS

- ADDED PROCEDURES CAUSED BY DOLLAR BILLS - Restricted Fares
- ADDED COST OF PROCEDURES - None
- LOST REVENUE - None known

METRO-SUBURBAN BUS AUTHORITY (MSBA)
EAST MEADOWS, LONG ISLAND, NEW YORK

TABLE 1 - PROPERTY CHARACTERISTICS

- BUSES - 320 'A' Coaches Total/270 Operational Daily
- FAREBOXES - 360 Total/270 Operational Daily
- PASSENGERS (1981) - 26 Million Total
- FARE STRUCTURE - 75¢ to $1.00
- ROUTES WITH FARES $\geq$ $1.00 - 35 percent
- ORGANIZATIONAL RESPONSIBILITY
  -Fare Sorting and Counting - Finance Department
  -Farebox Maintenance - Finance Department
  -Security of Fares - Finance Department

TABLE 2 - FARE COLLECTION METHODS

- TYPES OF FARES AND METHODS OF COLLECTION
  -Cash - Electronic Registering Fareboxes
  -Tokens - Transit Authorized Tokens
  -Passes - Sold through MSBA and Employers
- BILLS HANDLED DAILY - 3-4,000, normally; 6-7,000 during Summer
- METHOD BILL SORTING, STACKING AND COUNTING
  -Manual Sorting and Stacking
  -Machine Counting
- COST OF BILL SORTING, STACKING AND COUNTING
  -Number of People - Normally four (two at each of two facilities)
  -Length of Time - 16 man-hours per day

TABLE 3 - EQUIPMENT MAINTENANCE

- NUMBER OF FAREBOX MAINTENANCE PEOPLE - Six full-time
- FAREBOX-CAUSED ROAD CALLS - Pull-Ins only
- ADDED PROCEDURES AND PERSONNEL CAUSED BY DOLLAR BILLS - Six full-time

TABLE 4 - SECURITY REQUIREMENTS

- ADDED PROCEDURES CAUSED BY DOLLAR BILLS - None
- ADDED COST OF PROCEDURES - N/A
- LOST REVENUE - 15-20 percent

CITY TRANSIT SERVICE (CITRAN)
FORT WORTH, TEXAS

TABLE 1 - PROPERTY CHARACTERISTICS

- BUSES - 141 Total/135 Operational Daily
- FAREBOXES - 145 Total/135 Operational Daily
- PASSENBERS (1981) - 6 Million Total/23,000 Daily
- FARE STRUCTURE - $1.00 Express and Commuter
  - 60¢ in Town
  - Free Downtown Circulation
- ROUTES WITH FARES $\geq$ $1.00 - 13 percent
- ORGANIZATIONAL RESPONSIBILITY
  -Fare Sorting and Counting - Director of Operations
  -Farebox Maintenance - Director of Operations
  -Security of Fares - Director of Operations

TABLE 2 - FARE COLLECTION METHODS

- TYPES OF FARES AND METHODS OF COLLECTION
  -Cash - Electronic Registering Fareboxes; separate slot for bills
  -Tokens - Electronic Registering Fareboxes
  Sold through Vending Machines
  -Passes - Sold through CITRAN and Employers
- BILLS HANDLED DAILY - 300-500
- METHOD BILL SORTING, STACKING AND COUNTING
  -Manual Sorting and Stacking
  -Manual Counting
- COST OF BILL SORTING, STACKING AND COUNTING
  -Number or People - Two
  -Length of Time - Five man-hours per day

TABLE 3 - EQUIPMENT MAINTENANCE

- NUMBER OF FAREBOX MAINTENANCE PERSONNEL - Two
- FAREBOX-CAUSED ROAD CALLS - Bus taken out of Service
- ADDED PROCEDURES AND PERSONNNEL CAUSED BY DOLLAR BILLS - N/A

TABLE 4 - SECURITY REQUIREMENTS

- ADDED PROCEDURES CAUSED BY DOLLAR BILLS - None
- ADDED COST OF PROCEDURES - None
- LOST REVENUE - 10-15 percent

TRANSPORTATION DEPARTMENT
PUEBLO, COLORADO

TABLE 1 - PROPERTY CHARACTERISTICS

- BUSES - 25 Total/21 Operational Daily
- FAREBOXES - 40 Total/25 Operational Daily
- PASSENGERS (1981) - 1.5 Million Total/6,000 Daily
- FARE STRUCTURE - 35¢ Adults, 20¢ Students, 15¢ Elderly and Handicapped
  Subsidized by the City
- ROUTES WITH FARES $\geq$ $1.00 - None
- ORGANIZATIONAL RESPONSIBILITY
  -Fare Sorting and Counting -
  -Farebox Maintenance -
  -Security of Fares -

TABLE 2 - FARE COLLECTION METHODS

- TYPES OF FARES AND METHODS OF COLLECTION
  -Cash - Electronic and Electromechanical Registering Fareboxes;
  Separate Slot for Bills
  -Tokens- Electronic and Electromechanical Registering Fareboxes
  Sold through Vending Machines
  -Passes- Sold through the City and by Employers
- BILLS HANDLED - Two to four Daily
- METHOD BILL SORTING, STACKING AND COUNTING
  -Manual Sorting and Stacking
  -Manual Counting
- COST OF BILL SORTING, STACKING AND COUNTING
  -Number of People -
  -Length of Time - Not known

TABLE 3 - EQUIPMENT MAINTENANCE

- NUMBER OF MAINTENANCE PERSONNEL - One
- FAREBOX-CAUSED ROAD CALLS - Unknown
- ADDED PROCEDURES AND PERSONNEL CAUSED BY DOLLAR BILLS - None

TABLE 4 - SECURITY REQUIREMENTS

- ADDED PROCEDURES CAUSED BY DOLLAR BILLS - None
- ADDED COST OF PROCEDURES - None
- LEVEL LOST REVENUE/THEFT - Minimal

For additional copies of this publication, please contact:

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